# QAI Products & Services Catalogue (Draft v1)

Prepared from the provided GitHub materials. This draft organizes QAI offerings into products, services, industries, and compliance mappings, highlighting where QAI excels vs. classical methods.

## 1) Executive Summary

* QAI focuses on optimization, secure computation/cryptography, high‑dimensional simulation, sensing & perception, autonomy/robotics, and next‑gen computing infrastructure (QASI distributed supercomputer; QAI datacenter/OS; QAI processor & programmable matter; quantum sensors infused with AI).
* Service lines: consulting & integration, R&D & prototyping, training, cloud/on‑prem delivery, migration of 800+ legacy assets onto QAI platform.
* Differentiators: cross‑domain system engineering, domain‑driven blueprints (Industrial Engg, Systems Engg, Digital Society, CleanEarth, Domestic), and end‑to‑end toolchain (PLM, Ops, OS, Datacenter OS, NexGen Solution Framework).

## 2) Taxonomy & Scope

**Components:** Software | Hardware | Services  
**Deployment:** Cloud | On‑prem | Edge  
**Applications:** ML & Optimization | Cryptography/Security | Simulation/Modeling | Sensing/Robotics | Navigation | Systems Engineering  
**Delivery Artifacts:** Products (software/hardware), Frameworks/SDKs, Platforms/OS, Reference Architectures, Services & Training.

## 3) Core Product Lines (overview)

| Product Line | Primary Use Cases | Technology Stack | QAI Merit vs Classical | Key Functions | Typical I/O |
| --- | --- | --- | --- | --- | --- |
| **QASI Distributed Supercomputer** | Heterogeneous HPC across quantum, AI, and classical nodes; national programs; secure multi‑tenant research | Orchestrator + scheduler, hybrid quantum/classical runtimes, containerized pipelines; support for Qiskit/Cirq; policy & tenancy | Massive parallelism; hybrid workflows improve time‑to‑solution for combinatorics & simulation; orchestration abstracts hardware diversity | Orchestration, scheduling, policy, monitoring, workflow execution | Inputs: job graphs, models, datasets; Outputs: results, logs, artifacts |
| **QAI Datacenter & Datacenter OS** | Facility‑scale AI/quantum hosting; elastic clusters; energy‑aware ops | Datacenter OS, cluster manager, telemetry; ops automation; security controls | Holistic utilization of Q+AI accelerators; energy/performance optimization | Provisioning, capacity mgmt, telemetry, incident & change mgmt | Inputs: fleet inventory, workloads; Outputs: SLA/health metrics |
| **QAI OS** | Edge/robotics/embedded deployment; standardized runtime for QAI apps | Minimal OS w/ RT scheduling, device drivers for sensors/actuators, SDK bindings | Deterministic latencies; uniform APIs from edge→cloud; safety hooks | Runtime, device abstraction, sandboxing | Inputs: sensor streams; Outputs: control signals, model inferences |
| **QAI Processor & Programmable Matter** | Specialized compute + reconfigurable substrates; field robotics; adaptive materials | FPGA/ASIC or novel substrates; low‑level kernels; quantum/neuromorphic interfaces | Orders‑of‑magnitude efficiency for targeted kernels; spatial reconfigurability | Signal processing, kernel acceleration | Inputs: bitstreams/graphs; Outputs: accelerated tensors/signals |
| **Quantum Sensors with AI** | High‑sensitivity sensing (mag/gravimetric, inertial, imaging); navigation | Quantum sensing front‑ends + AI filtering/fusion; calibration pipeline | SNR gains; drift compensation; robust navigation in GPS‑denied contexts | Sensing, fusion, calibration, diagnostics | Inputs: raw sensor data; Outputs: fused states/alerts |
| **GenAI\_QAI Framework** | Domain‑aware copilots/agents powered by hybrid Q+AI | LLMs/agents, retrieval, domain ontologies, hybrid solvers | Better solutions for planning/optimization; verifiable steps | RAG, agent orchestration, solver calls | Inputs: prompts, corpora; Outputs: actions, plans, validated results |
| **QAI NexGen Solution Framework (NexGen\_Sol\_FW)** | Rapid solution assembly across domains | Templates, pipelines, reference models, compliance packs | Faster delivery with governance built‑in | Blueprints, code‑gen, CI/CD | Inputs: requirements; Outputs: packaged solutions |
| **QAI PLM** | Lifecycle from ideation→decommission for QAI assets | PLM repo, SBOM, model cards, dataset lineage | Auditability; reuse; safety-by-design | Governance, versioning, approvals | Inputs: designs, models; Outputs: releases, traces |
| **QAI Ops** | Observability & reliability for QAI systems | Telemetry, drift/bit‑flip monitors, incident mgmt | Improved MTTR; resilience to noise & drift | Monitoring, alerting, SRE | Inputs: logs/metrics; Outputs: KPIs, runbooks |
| **QAI for Robots** | Autonomy stacks; manipulation; swarm | Perception, planning, control; sim‑in‑the‑loop | Hybrid planning; robust control in uncertain envs | SLAM, MPC, task planning | Inputs: sensors/maps; Outputs: trajectories/actuation |

## 4) Detailed Use‑Case Catalogue (selected)

| Use Case | Product/Module | Technology Stack | QAI Merit | Functions | I/O |
| --- | --- | --- | --- | --- | --- |
| GPS‑denied Navigation | Quantum Sensors + GenAI\_QAI | Atom interferometry / magnetometry + sensor fusion + LLM agent | Higher sensitivity, robustness; explainable agent loop | Sense→Fuse→Estimate→Plan | In: IMU, magnetometer; Out: pose, route |
| Portfolio Optimization | QASI + Hybrid Solvers | QAOA/VQE + classical optimizers; finance datasets | Better optima for combinatorics; faster what‑ifs | Solve→Validate→Report | In: returns/covariance; Out: weights/risk |
| Smart Grid Scheduling | QAI Datacenter/OS | RL + quantum annealing; telemetry | Energy cost savings; peak load reduction | Forecast→Dispatch | In: grid telemetry; Out: schedules |
| Drug/Thermo Simulation | QASI + Sim/Modeling | Hybrid quantum chemistry sim | Reduced simulation time; higher fidelity | Simulate→Analyze | In: molecule graph; Out: energies |
| Industrial Vision QA | QAI OS + Edge | CV + quantum‑assisted search for defects | Higher detection at lower latency | Acquire→Infer→Flag | In: images; Out: pass/fail |
| Swarm Coordination | QAI for Robots | Multi‑agent RL + combinatorial solvers | Scales better; resilient | Perceive→Plan→Coordinate | In: swarm state; Out: commands |
| Urban Digital Twin | NexGen\_Sol\_FW | Knowledge graph + sim | Planning w/ constraints; policy testing | Model→Sim→Advise | In: city data; Out: dashboards |
| CleanEarth Monitoring | QAI for CleanEarth | Quantum sensors + EO data + anomaly AI | Detects weak signals; target discovery | Sense→Fuse→Alert | In: EO/sensors; Out: alerts |

Extendable: add rows per domain pack (Industrial Engg, Systems Engg, Domestic, Digital Society, Robotics, Datacenter, Processor/Programmable Matter, PLM, Ops, OS).

## 5) Industry & Sector Mapping

### 5.1 Industries (sample)

| Industry | Priority Use Cases | QAI Product(s) | Value/Merit |
| --- | --- | --- | --- |
| Healthcare | Protein folding, imaging reconstruction, scheduling | QASI, GenAI\_QAI | Faster discovery; better throughput |
| Finance | Risk, fraud, portfolio, settlement | QASI, NexGen\_Sol\_FW | Better optima; traceability |
| Manufacturing | Visual QA, predictive maintenance, scheduling | QAI OS, QAI for Industrial Engg | Lower defects; OEE↑ |
| Energy/Utilities | Grid optimization, subsurface modeling | QAI Datacenter, QASI | Cost ↓; reliability ↑ |
| Space/Aero | Navigation, mission planning, materials | Quantum Sensors+AI, QAI Processor | GPS‑independent nav; mass/power savings |
| Telecom | Network planning, anomaly detection | NexGen\_Sol\_FW, QASI | Capex/opex optimization |

### 5.2 Research Units

| Unit | Focus | Tooling |
| --- | --- | --- |
| Lab Works | Prototypes, toy models, demonstrators | QASI, GenAI\_QAI, Sensors |
| Research Assets | Algorithms, datasets, papers | PLM, Model Cards, Repos |
| Technology Incubation | TRL uplift & pilots | NexGen\_Sol\_FW, Ops, OS |

### 5.3 Domestic/Home Use

| Scenario | Product | Merit |
| --- | --- | --- |
| Energy‑aware Home | QAI OS (edge) | Smart scheduling & savings |
| Assistive Robotics | QAI for Robots (home) | Safer navigation & manipulation |
| Privacy‑Preserving AI | GenAI\_QAI (local) | On‑device inference; policy control |

### 5.4 Hi‑Tech Programs / National Security & Defense

| Mission Thread | Product | Tech Stack | QAI Merit |
| --- | --- | --- | --- |
| ISR Sensing | Quantum Sensors + AI | Quantum sensing + fusion + anomaly detection | Higher sensitivity; fewer false positives |
| GPS‑Denied Ops | Sensors + Agents | Inertial + magnetics + agentic planning | Resilient navigation |
| Crypto & Comms | QASI + PQC | Post‑quantum crypto integration + HSMs | Future‑proof security |
| Wargaming/COA | QASI + GenAI\_QAI | Hybrid solvers + agent simulators | Faster COA exploration |

## 6) Standards & Compliance Mapping

### 6.1 Industry 5.0 (human‑centric, resilient, sustainable)

| Pillar | QAI Features | Evidence of Merit |
| --- | --- | --- |
| Human‑centric | Domain copilots; explainable agent loop; safety hooks in OS | Reduced cognitive load; audit trails |
| Resilience | Hybrid solvers; drift/bit‑flip monitors; redundant sensing | Faster recovery; graceful degradation |
| Sustainability | Energy‑aware scheduling; programmable matter efficiency | Lower energy per task; green SLAs |

### 6.2 Society 5.0 (super‑smart society)

| Theme | QAI Contribution |
| --- | --- |
| Inclusive Services | Low‑latency edge inference; accessibility copilots |
| Safe Mobility | GPS‑independent navigation; autonomy safety checks |
| Smart Infrastructure | Digital twins with policy simulation |

### 6.3 NIST Cybersecurity Framework (CSF 2.0)

| Function | QAI Controls/Artifacts | Examples |
| --- | --- | --- |
| Identify | PLM, SBOMs, model registry, asset CMDB | Model cards, dataset lineage |
| Protect | QAI OS sandboxing, PQC integration, least‑privilege runtimes | Secrets mgmt, enclave execution |
| Detect | Telemetry, anomaly detection across sensors & workloads | Drift monitors, tamper alerts |
| Respond | Runbooks, auto‑rollback, incident orchestration in QASI/Datacenter OS | Hot patching, quarantines |
| Recover | Provenance‑backed restore, reproducible builds | Clean room rebuilds, disaster exercises |

## 7) Where QAI Shines vs. Classical (and where it doesn’t)

**Strengths**  
- Combinatorial optimization (routing, scheduling, portfolio) via hybrid solvers.  
- High‑fidelity simulation (chemistry/materials) accelerations.  
- Extreme‑sensitivity sensing with AI fusion; robust navigation.  
- Cross‑domain orchestration at datacenter/HPC scale (QASI).

**Current Limitations**  
- Hardware maturity & noise; algorithmic speedups problem‑dependent.  
- Integration complexity; requires strong governance (PLM/ops).  
- Skilled‑talent needs; safety/ethics & model drift management remain essential.

**Mitigations**  
- Start with hybrid pilots; use PLM for traceability; design for graceful fallback to classical baselines; invest in Ops and observability.

## 8) Technology Stack Summary

* **Hardware:** Quantum processors (superconducting/trapped‑ion), specialized QAI processors/programmable matter, quantum sensors, GPUs/CPUs, edge devices.
* **Software:** Qiskit, Cirq; GenAI frameworks; orchestration (QASI), Datacenter OS, QAI OS; PLM/Ops; templates in NexGen Solution Framework.
* **Data & Models:** Model cards, datasets with lineage, simulation models, domain ontologies.

## 9) Migration & Delivery Roadmap

1. **Inventory & Prioritize** legacy assets → CMDB/PLM.
2. **Blueprint** with NexGen Solution Framework + compliance packs.
3. **Pilot** hybrid QAI workloads on QASI/Datacenter OS.
4. **Harden** with QAI OS, Ops, and security integration (NIST CSF).
5. **Scale** across industry packs (Industrial Engg, Systems Engg, Digital Society, CleanEarth, Domestic).
6. **Operate** via SLOs, cost/energy KPIs, periodic model re‑validation.

## 10) Appendices

* **Glossary** (QAI, QASI, PLM, PQC, RAG, MPC, SLAM, SBOM, CMDB, TRL, OEE).
* **Asset Index (expandable):** GenAI\_QAI, GenAI\_Robotics, QAI\_Processor, QAI\_Processor\_Programmable\_Matter, QAI\_OS, QAI\_Datacenter, QAI\_Datacenter\_OS, QAI\_Ops, QAI\_PLM, QAI\_for\_Industrial\_Engg, QAI\_for\_SysEngg, QAI\_for\_Digital\_Society, QAI\_for\_CleanEarth, QAI\_for\_Robots, migration\_paths, engg\_codesign, Quantum sensors enriched with AI, QAI\_NexGen\_Sol\_FW, QASI Distributed Supercomputer.

**Next:** Populate each product with deeper specs (APIs, SLAs, deployment patterns, security controls, TRL), and extend the Use‑Case table per industry with measurable KPIs.